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AUTHOR Woodward, James; Allen, Thomas
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ABSTRACT

A study examined English grammatical characteristics used in the signing of teachers of hearing-impaired students, using a diglossic continuum between American Sign Language (ASL) and English. Scalogram analysis or implicational scaling, a traditional tool in variation theory useful for analyzing samples where there are a small number of tokens for each linguistic characteristic, and Rasch analysis, traditionally used in scaling test items, were performed on teacher's self-reported signing behavior in two English sentences. Teachers indicated whether they would fingerspell, use a separate sign or gesture, include as part of another sign, or omit specific words in the sentences, in order to communicate the meanings of the sentences. It is concluded that Rasch analysis not only provides the same descriptive information as scalogram analysis, but that it also provides information not available through scalogram analysis. Moreover, it was found to be possible to convert information obtained with the Rasch model into a scalogram model. Since the Rasch model appears to be a more powerful tool for analyzing variation along a continuum than scalogram analysis, it would be useful for linguists analyzing variation along a continuum to begin using Rasch analysis with or instead of implicational scales. (MSE)

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TWO ANALYSES OF THE ASL TO ENGLISH CONTINUUM

James Woodward and Thomas Allen

Center for Assessment and Demographic Studies
The Gallaudet Research Institute

1.0 Introduction

Studies of sign language variation in the United States have traditionally posited a diglossic continuum between American Sign Language (ASL) and English (Stokoe 1969, 1973; Hoores 1972, Woodward 1972); however, little empirical research has explored the nature of this continuum. Research to date (Woodward 1973a,b,c 1974) has shown that variation along this continuum is non-discrete, but regular, rule-governed, and describable in terms of variation theory in sociolinguistics (Bailey 1973, Sankoff 1978, Wolfram and Fasold 1974). This research on the variation between ASL and English has focused primarily on the use of ASL characteristics in signing. No large scale empirical research has focused on the use of English characteristics in signing along this continuum.

The purpose of the present study is to examine English grammatical characteristics used in the signing of teachers of hearing-impaired students. We will first perform a scalogram analysis or implicational scaling (Bickerton 1971), a traditional tool in variation theory that is useful for analyzing samples where there are a small number of tokens for each linguistic characteristic. We will then perform a Rasch analysis, which has traditionally been used in scaling test items. From these analyses, we will draw conclusions about the regularity of English characteristics in signing along the ASL to English continuum and compare the relative usefulness of the scalogram and the Rasch models in describing the data.

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Read the following two English sentences:

1) He is looking at me.
2) I am looking for him.

A. When communicating the meaning of the two English sentences above to the named student in the classroom, indicate how you would communicate each of the following:
(a. Would fingerspell; b. Would use separate sign or gesture; c. Would include as part of another sign; d. Would omit)

He	(a, b, c, or d?)	I	(a, b, c, or d?)
is	(a, b, c, or d?)	am	(a, b, c, or d?)
look	(a, b, c, or d?)	look	(a, b, c, or d?)
-ing	(a, b, c, or d?)	-ing	(a, b, c, or d?)
at	(a, b, c, or d?)	for	(a, b, c, or d?)
me	(a, b, c, or d?)	him	(a, b, c, or d?)

B. When communicating the meaning of the two English sentences above to this student in the classroom, indicate how you would normally sign the following words:
(a. Would use the same sign for each; b. Would use a different sign for each; c. Would not sign one or both of these words)

He and Him	(a, b, or c?)
I and Me	(a, b, or c?)
Am and Is	(a, b, or c?)
Look in both sentences	(a, b, or c?)

The self-reported data was coded as follows: For section A, all "a" (fingerspelled) or "b" (signed with a separate sign) responses were considered to be English-like. For section B, all "b" (different sign) responses for He and Him, I and Me, and Am and Is were considered to be English-like. For Look in both sentences, "a" (use the same sign) was considered to be English-like. All other responses were considered to be less English-like. This coding resulted in an item-vector containing 16 dichotomous elements.

3.0 Results of the Scalogram Analysis

Variation theory in sociolinguistics has used two primary models to describe linguistic variation: implicational scaling (scalogram analysis) and variable rules. While these two models were originally seen as competitive (Fasold 1970), the wave model in sociolinguistics (Bailey 1973) has shown that the two models are quite complementary and can be integrated in sociolinguistic analysis. Used alone, however, there is one disadvantage to each model. The disadvantage of variable rule analysis is that it generally require more tokens from each individual than scalogram analysis. The disadvantage to scalogram analysis is that it cannot be used to predict probabilities in language use.

Studies of variation along the ASL to English continuum have used implicational scaling rather than variable rules, due to the problems and expense involved in recording sufficient sign language data on videotape for variable rule analysis. Since the data collected for this paper are not sufficient to perform variable rule analysis, we will only discuss the assumptions underlying scalogram analysis.

Scalogram analysis assumes that variables will be implicationally related to each other so that the occurrence of variable "1" will imply the occurrence of variable "2" but not vice-versa. Moreover, the occurrence of variable "2" will imply the occurrence of variable "3" but not vice-versa, etc. Variables generally have the values of "+" (present), and "-" (absent). Sometimes the value "x" (variably present) is also used. An alternative method allows for the use of actual percentages of occurrence. In this analysis, we use a three valued scale "categorically present", "variably present", and "categorically absent".

After a number of attempts to scale all the items on the same scale, it became clear that the answers to the two parts of the question could not be placed on the same implicational scale. There must be two separate scales, one for grammatical information and one for lexical information.

Table 1 shows the results of the analysis of the grammatical items. Group 1 is the closest to English grammatical structure; group 17 is the closest to ASL grammatical structure. The term "present" means that both tokens of the unit were represented manually (signed and/or fingerspelled) as separate units by the teachers. The word "variable"

means that only one of the two tokens of the unit were manually represented as separate signed and/or fingerspelled units. "Absent" means that both tokens were either included as part of another sign or omitted. The items on the right tend to be deleted more frequently than the items on the left. For example, the categorical presence of progressive -ing implies the categorical presence of all other English grammatical characteristics. Variable presence of -ing implies variable or categorical presence of all other English grammatical characteristics. If -ing is absent, the next item that serves as a predictor is the use of prepositions. Categorical presence of a preposition implies the categorical presence of all English grammatical characteristics to the left. Variable presence of a preposition implies variable or categorical presence of all English characteristics to the left. In summary, the manual representation of progressive -ing implies the use of prepositions which implies the use of the copulas which implies the presence of free object pronouns which implies the use of free subject pronouns. The verb is present in all sentences. Stated another way, English inflections are most frequently omitted followed by English function words, followed by English content words.

TABLE 1: GRAMMATICAL SCALE WITH PREPOSITIONS

Group	Main Verb Look1/Look2	Subject He/I	Object He/Him	Copula Is/Am	Preposition At/For	Progressive -Ing1/-Ing2	Number of Signers
1	Present	Present	Present	Present	Present	Present	468
2	Present	Present	Present	Present	Present	Variable	25
3	Present	Present	Present	Present	Variable	Variable	21
4	Present	Present	Present	Variable	Variable	Variable	1
5	Present	Present	Present	Present	Present	Absent	265
6	Present	Present	Present	Present	Variable	Absent	53
7	Present	Present	Present	Variable	Variable	Absent	21
8	Present	Present	Variable	Variable	Variable	Absent	5
9	Present	Present	Present	Present	Absent	Absent	13
10	Present	Present	Present	Variable	Absent	Absent	6
11	Present	Present	Variable	Variable	Absent	Absent	2
12	Present	Present	Present	Absent	Absent	Absent	39
13	Present	Present	Variable	Absent	Absent	Absent	21
14	Present	Variable	Variable	Absent	Absent	Absent	7
15	Present	Present	Absent	Absent	Absent	Absent	2
16	Present	Variable	Absent	Absent	Absent	Absent	2
17	Present	Absent	Absent	Absent	Absent	Absent	5

The self-reported signing data from the teachers fit the implication in an acceptable fashion; 956 signers out of 1,135 (84.2%) follow the pattern in Table 1. However, many linguists prefer a higher percentage of scalability. Indeed once one examines the signers who do not fit the implication, it becomes clear that a very large number of the exceptions involve the use of prepositions.

As Table 2 indicates, once the prepositions are removed from the scale, there is a very high rate of scalability, 95.7% (1,086 out of 1,135 signers). The irregularity of the prepositions in these data may indicate an irregularity in prepositional usage along the ASL to English continuum or it may indicate that there are separate scales that need to be developed for prepositional usage.

TABLE 2: GRAMMATICAL SCALE WITHOUT PREPOSITIONS

Group	Main Verb Look1/Look2	Subject He/I	Object He/Him	Copula Is/Am	Progressive -Ing1/-Ing2	Number of Signers
1	Present	Present	Present	Present	Present	481
2	Present	Present	Present	Present	Variable	47
3	Present	Present	Present	Variable	Variable	3
4	Present	Present	Variable	Variable	Variable	1
5	Present	Present	Present	Present	Absent	331
6	Present	Present	Present	Variable	Absent	39
7	Present	Present	Variable	Variable	Absent	9
8	Present	Present	Present	Absent	Absent	120
9	Present	Present	Variable	Absent	Absent	36
10	Present	Variable	Variable	Absent	Absent	9
11	Present	Present	Absent	Absent	Absent	2
12	Present	Variable	Absent	Absent	Absent	3
13	Present	Absent	Absent	Absent	Absent	5

In addition to the grammatical implication, there is also a lexical implication for those people who have a separate sign for expressing "am" and "is", "I" and "me", "he" and "him", "look" in both sentences. Table 3 illustrates this implication.

TABLE 3: LEXICAL SIGN SCALE

Group	Look3	HeHim	IMe	AmIs	Number of Signers
1	same	different	different	different	253
2	different	different	different	different	319
3	different	same	different	different	32
4	different	same	same	different	2
5	different	same	same	same	1

The great majority of teachers (607 out of 644 or 94.3%) follow this pattern. Signers who did not have a separate sign for each of these words in each of the sentences were eliminated from the analysis. Group 1 has the greatest similarity to English lexicalization in the two sentences: separate lexicalization of all items except for "look". Group 5 has the greatest similarity of ASL lexicalization in the two sentences: separate lexicalization only for "look". Copulas receive English lexicalization before "I" and "me", which receive English lexicalization before "he" and "him", which receive English lexicalization before "look".

3.1 Results of the Rasch Analysis

The data were analyzed with MICROSCALE, a Rasch scaling program (Wright and Linacre 1984). In a Rasch analysis, the responses (the signs) and the respondents (the signers) are placed on the same numerical scale. For signers, the scale represents the level of English in their signing; for the linguistic elements, the scale represents the level of English necessary in a person's signing for it to be given an English response.

The unit of measure in a Rasch analysis is a "logit"; the logit scale is constructed such that if the scale value assigned to a signer equals the scale value assigned to a given linguistic element, then the signer will emit the English response to the linguistic element 50% of the time. Thus the Rasch model differs significantly from the implicational scaling model since the elements are related probabilistically rather than implicationally. The relationship between the linguistic element scale and the signer scale is fixed so that the probability of an English response can be easily calculated from the difference between the scale value assigned to any signer and the scale value assigned to any linguistic element. The following chart shows the probabilities that a signer will give an English response to a scaled linguistic element, given the specified difference between the scale value assigned to the signer and the scale value assigned to the linguistic element (Wright & Stone, 1979). As an example, signers assigned logit scale values of 4.0 should emit English responses 95% of the time to linguistic elements assigned logit values of 1.0, since the difference between the two values equals 3.0.

Logit difference between signer's and linguistic element's English ratings E(Signer)-E(SynE)	Probability of signer giving English response
3.0	.95
2.2	.90
1.1	.75
0	.50
-1.1	.25
-2.2	.10
-3.0	.05

There is an important assumption related to the application of the Rasch analysis to the current data set. The Rasch analysis specifies that the underlying trait being measured (in this case the degree of English in a person's signing) is unidimensional in a factor analytic sense.

Fortunately, the Rasch analysis procedure yields some statistics which allow us to examine the credibility of the unidimensional assumption through the computation of fit statistics. These are computed both for signers and for the syntactical elements. The goal of the analysis is to derive a scale in which the probability of an English response to a given syntactical element by a signer with a higher level of English signing is ALWAYS greater than the probability of an English response by a person with lower level of English signing. Similarly, when we evaluate the fit of the derived scale to the linguistic elements, we hope to find that the probability of a given person providing the English response to an element that is higher on the scale will ALWAYS be less than the probability of the same person giving an English response to an element that is lower on the scale. When the actual response patterns of signers and of linguistic elements do not fit those specified by the model, we can suspect that the underlying trait being measured is not unidimensional.

Table 4 presents the number and proportion of signers indicating the English response to each of the 16 grammatical and lexical elements included in the scale. It also presents the logit values assigned to each of the elements and the fit statistics computed for each element.

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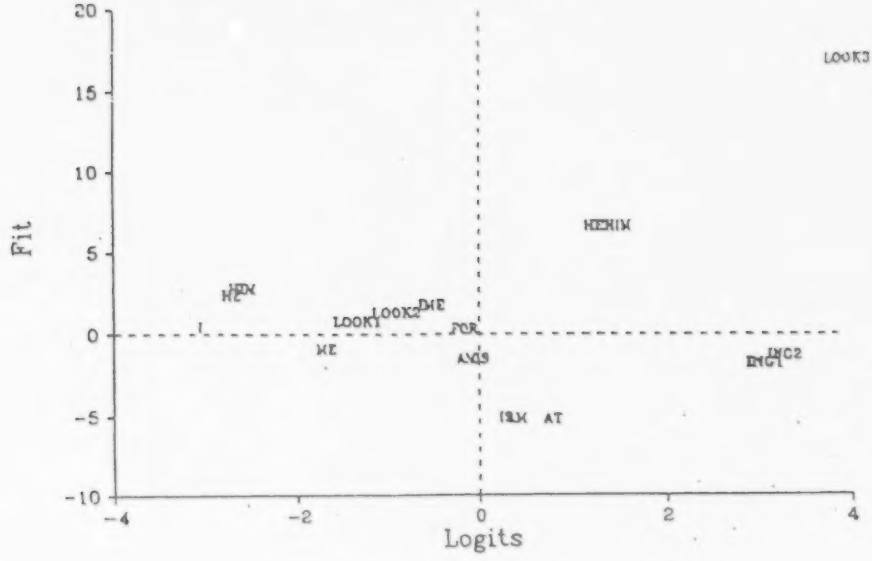
TABLE 4: RESULTS OF RASCH ANALYSIS

	Number With English Response	% With English Response	Logits	Fit
HE	1104	97%	-2.73	1.65
IS	916	81%	0.28	-5.83
LOOK1	1048	92%	-1.34	0.05
-ING1	547	48%	3.02	-2.52
AT	862	76%	0.77	-5.89
ME	1066	94%	-1.68	-1.64
I	1112	98%	-3.09	-0.28
AM	905	80%	0.39	-5.84
LOOK2	1021	90%	-0.92	0.61
-ING2	514	45%	3.23	-2.06
FOR	961	85%	-0.18	-0.41
HIM	1101	97%	-2.61	2.07
HEHIM	789	70%	1.36	5.93
IME	992	88%	-0.54	1.05
AMIS	937	83%	-0.08	-2.25
LOOK3	410	36%	3.96	16.29

Figure 1 shows a scatterplot of logits against fit statistics as found in Table 4.

The horizontal axis in Figure 1 represents the degree of English of the given responses; the vertical axis represents how well the items fit the model's expected probabilities. Relating to the horizontal axis, the left side of Figure 1 represents units that occur in both ASL and English signing. The further units are to the right side of the scale, the more English they are.

Figure 1
Plot of logit values against fit statistics



In general, the following can be observed:

Subjects of sentences require the "least" English,
i.e., the elements are signed or fingerspelled
separately by virtually everyone;
then objects;
then verbs;
then the preposition "for";
then copulas;
then separate lexicalization for "am" and "is";
then the preposition "at",
then separate lexicalization for "he" and "him";
then the progressive "ing";
finally, the same lexicalization for "look" in
both sentences.

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While there is regularity in the order of the occurrence of items, the analysis indicates that there are two problems with the data, one relating to the horizontal axis and one relating to the vertical axis. The problem in the horizontal axis is that too many of the items scale to the left of center and too few to the right. This indicates: 1) there is a problem with the type of items chosen for the scale or 2) a different sample of signers is needed. The answer we choose relates to the primary purpose of our analysis. If our primary purpose was solely to distinguish the types of signing used by different teachers, more "English-y" items, such as inflections, are needed, since most teachers used a great deal of the English in their signing. On the other hand, if we obtained a sample that contained more deaf people (only 10% of the sample is deaf), whom we would expect to sign less English and more ASL, we might find that the items are satisfactory to discriminate among different types of signers.

In addition to the problem in the horizontal or "English-y" axis, there are problems in the vertical axis, which illustrates the fit statistics of the items. A fit statistic equal to 0 indicates a perfect fit of an item to a scale, i.e., the actual probabilities of signers with specified logit values giving English responses to items with perfect fit are precisely those predicted by the Rasch model. When the fit statistic for a given item deviates from 0, lack of fit can be noted. Two different kinds of fit problems can be described: high positive values and high negative values. High positive values occur when an element with a high English score is given an English response by low scorers on the scale, or when an element with a low scale value is not given an English response by high scorers on the scale. The scale value assigned to the element does not appropriately discriminate signers with high and low English scores.

High negative values occur for signs that are too discriminating, i.e. if a person is assigned a scale value of 1 logit, they will actually demonstrate English signing greater than 50% of the time to elements which are also assigned a logit value equal to 1. A plot of the relationship between logit differences between signers and linguistic elements with high negative fit statistics would show a steeper slope than would be evident from plotting the numbers in the logit difference chart presented earlier.

In the current scaling, a number of the items included showed poor fit. In Figure 1, it can be noted that there is a "conical" shape to the scatter of elements. This indicates that lack of fit is more closely associated with items that are higher on the scale, i.e., are only given an English response by the more English signers.

Elements with high positive fit statistics (>2.5) include "hehim" (i.e., signing he and him differently in similar semantic contexts) and "look3" (i.e., signing look similarly in different semantic contexts). These fit statistics suggest that the preference for signing in English is multidimensional. It might be argued that there is a single dimension dictated by whether or not specific grammatical units will be signed or fingerspelled separately, but this grammatical continuum does not account for decisions about preference for English or ASL- like lexicalization. There needs to be a separate scale which looks only at this issue.

Elements with high negative values (<-2.5) include "is", "ingl", "at", and "am". These include both occurrences of the verb to be, a preposition, and one of the two uses of the progressive "-ing" inflection. These fit statistics suggest that the use of these items are more categorical than other items, i.e. they are probably better described as discrete than as an intrinsically variable part of a continuum.

In addition to the above information, Rasch analysis also gives information about probability of various levels of English signing. To do this, we need to use the following formula from Wright and Stone (1979):

$$P = \exp(D) / 1 + \exp(D)$$

where P = probability of an English response to a sign, and D = (signer logit - sign logit)

First, subtract the logit value of a given sign in Table 4 from the logit value of the a given group of signers shown in Table 5. Second, take the exponent of the answer in step one. Third, divide the number obtained in step two by 1 + itself. The result will be the probability of the given group of signers signing the given sign. (It should be noted that 181 of the 1135 signers (16%) provided English responses to all 16 grammatical and lexical elements. Since they have "perfect" English scores, there is no way to

assign a probability level of English signing for these signers. Therefore, these signers are not assigned logit values.)

TABLE 5: LOGIT VALUES FOR SIGNERS

Logit Value	Number of Signers	Percent of Signers
4.27	249	21.9%
3.24	140	12.3%
2.44	158	13.9%
1.77	99	8.7%
1.21	63	5.6%
0.72	37	3.3%
0.29	40	3.5%
-0.13	42	3.7%
-0.54	53	4.7%
-0.95	29	2.6%
-1.39	20	1.8%
-1.86	11	1.0%
-2.39	11	1.0%
-3.02	1	0.1%
-3.90	1	0.1%

Table 6 illustrates a probability chart that can be derived for the above calculations. The probabilities of signing or fingerspelling "he", "me", "is", "at", and "-ing" for signers with the highest (most English) logit value of 4.27 are shown on the top line; the probabilities for signers with the next highest logit value (3.24) are shown on line 2; the probabilities for signers with the lowest logit level (least English) of -3.90 are given on the last line.

TABLE 6: PROBABILITIES GENERATED BY THE RASCH MODEL FOR SIGNING "HE", "ME", "IS", "AT", "-ING"

Signer Logit	HE	ME	IS	AT	-ING	Number of Signers
4.27	1	1	.98	.97	.79	249
3.24	1	.99	.95	.92	.55	140
2.44	.99	.98	.88	.85	.35	158
1.77	.99	.97	.82	.73	.21	99
1.21	.98	.95	.71	.60	.14	63
.72	.97	.92	.60	.53	.10	37
.29	.95	.88	.50	.38	.06	40
-.13	.93	.83	.40	.29	.04	42
-.54	.88	.75	.31	.21	.03	53
-.95	.86	.67	.23	.10	.02	29
-1.39	.79	.57	.15	.10	.01	20
-1.86	.71	.45	.10	.07	.01	11
-2.39	.57	.33	.06	.04	0	11
-3.02	.43	.21	.04	.02	0	1
-3.90	.23	.10	.01	.01	0	1

4.0 Comparison of the Two Analyses

Both the scalogram and Rasch models show similar results in scaling the same linguistic data. Both models indicate that grammatical and lexical items should be represented on different scales. Both models agree on the order of scaling in the grammatical and the lexical scales. For the grammatical scale, the use of English inflections implies the use of English function words, which implies the use of English content words. For the lexical scale, the English representation of "look" implies the English representation of pronouns, which implies English representation of copulas.

While the analyses scale the data in similar ways, there are several important advantages to the Rasch analysis. First, the Rasch analysis intrinsically indicates that the test items or the sample need to be modified. This has to be inferred from the scalogram analysis. Second, the fit statistics in the Rasch model immediately indicate that the items with unacceptable fit statistics must be scaled multidimensionally. The scalogram analysis requires a number of tries before this is evident. Third, the fit

statistics in the Rasch model immediately indicate that items with negative fit statistics are more discrete than other items. This information must be inferred from the scalogram analysis. Finally, the Rasch model gives information about the probability of various levels of English signing. The scalogram analysis cannot provide probabilities.

In summary, Rasch analysis not only provides the same descriptive information as scalogram analysis, it also provides information not available through scalogram analysis. Moreover, it is possible to convert information obtained from the Rasch model into a scalogram model. Since Rasch analysis is a much more powerful tool for analyzing variation along a continuum than scalogram analysis, it would be useful for linguists analyzing language variation along a continuum to begin using Rasch analysis with or instead of implicational scales.

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NOTE

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